What is claimed is:

1. A decoder adapted to determining a log likelihood logarithmically expressing the probability of passing an arbitrary state on the basis of the value received as soft-input encoded so as to provide at least three or more paths for getting to each state and decoding by using the log likelihood, said decoder comprising:

a path selection means for obtaining at least two or more paths showing a high likelihood out of the at least three or more paths for getting to each state and selecting the maximum likelihood path from the obtained at least two or more paths.

2. The decoder according to claim 1, wherein said path selection means has a comparison means for comparing the likelihoods of all the combinations of two paths selected from all the three or more than three paths getting to each state.

3. The decoder according to claim 1, further comprising:

an absolute value selection means for selecting the absolute value of the difference between the data corresponding to the maximum likelihood path and the data corresponding the second maximum likelihood path.

4. The decoder according to claim 3, wherein said absolute value selection means has an absolute value computing means for computing the absolute value of the difference of each of all the combinations of two paths

-85-

selected from all the three or more than three paths getting to each state;

the computed absolute values being compared for magnitude on the basis of the information on the outcome of comparison obtained by comparing the likelihood of each of all the combinations of two paths selected from all the three or more than three paths getting to each state by means of said path selection means.

5. The decoder according to claim 3, further comprising:

a linear approximation means for computing by linear approximation a correction term added to obtain said log likelihood and expressed by a one-dimensional function relative to a variable;

said linear approximation means using as said variable the absolute value of the difference between the data corresponding to said maximum likelihood path and fed from said absolute value selection means and the data corresponding to said second maximum likelihood path.

6. The decoder according to claim 5, wherein said linear approximation means computes said correction term by expressing the coefficient representing the gradient of said function for multiplying said variable at least by means of a power exponent of 2.

7. The decoder according to claim 6, wherein said linear approximation means discards lower bits of an input data according to the power exponent expressing the coefficient representing the gradient of said function.

8. The decoder according to claim 6, wherein said linear approximation means discards the bits from the lowest bit to the k-th lowest bit of the input data when the coefficient representing the gradient of said function is expressed by -2^{-k}.

9. The decoder according to claim 6, wherein said linear approximation means computes said correction term by expressing the coefficient representing the intercept of said function by means of a power exponent of 2.

10. The decoder according to claim 9, wherein said linear approximation means computes said correction term by expressing the coefficient representing the intercept of said function by means $2^m - 1$.

11. The decoder according to claim 10, wherein said linear approximation means discards the bits from the lowest bit to the k-th lowest bit of the n-bit input data and inverts the m bits from the k+1-th lowest bit to the m+k-th lowest bit when the coefficient representing the gradient of said function is expressed by means of -2^{-k}.

12. The decoder according to claim 6, wherein said correction term shows a positive value.

13. The decoder according to claim 12, wherein said linear approximation means makes the correction term equal to 0 when a negative value is produced by computing said correction term.

14. The decoder according to claim 1, wherein said log likelihood is a

-87-

log expression of said probability, using the natural logarithm.

15. The decoder according to claim 1, further comprising:

a first probability computing means for computing for each received value a first log likelihood logarithmically expressing a first probability determined by a code output pattern and said received value;

a second probability computing means for computing for each received value a second log likelihood logarithmically expressing a second probability of getting to each state from a coding starting state in the time series; and

a third probability computing means for computing for each received value a third log likelihood logarithmically expressing a third probability of getting to each state from a coding terminating state in the inverted time series;

said second probability computing means and said third probability computing means having path selection means, respectively.

16. The decoder according to claim 15, further comprising:

a soft-output determining means for determining a log soft-output logarithmically expressing the soft-output in each time slot, using said first log likelihood, said second log likelihood and said third log likelihood.

17. The decoder according to claim 16, wherein said log soft-output is a logarithmic expression of said soft-output with the natural logarithm.

18. The decoder according to claim 15, wherein said second probability computing means and said third probability computing means have absolute

-88-

value selection means for determining the absolute value of the difference between the data corresponding to the maximum likelihood path and the data corresponding to the second maximum likelihood path showing the second highest likelihood, respectively.

19. The decoder according to claim 15, wherein said second probability computing means and said third probability computing means have linear approximation means for computing by linear approximation the correction term added to obtain said log likelihood and expressed by a one-dimensional function relative to a variable, respectively.

20. The decoder according to claim 1, wherein said log likelihood is determined by computations replacing the multiplications for computing the probability by logarithmic additions and the additions for computing the probability by logarithmic maximum value computations.

21. The decoder according to claim 20, wherein a maximum a posteriori probability decoding operation is conducted on the basis of the Max-Log-BCJR algorithm.

22. The decoder according to claim 5, wherein said log likelihood is determined by computations replacing the multiplications for computing the probability by logarithmic additions and the additions for computing the probability by logarithmic maximum value computations and computations of said function.

23. The decoder according to claim 22, wherein a maximum a posteriori probability decoding operation is conducted on the basis of the Log-BCJR algorithm.

24. The decoder according to claim 1, wherein convolutional codes are decoded.

25. A decoding method adapted to determining a log likelihood logarithmically expressing the probability of passing an arbitrary state on the basis of the value received as a soft-input encoded so as to provide at least three or more paths for getting to each state and decoding by using the log likelihood, said decoding method comprising:

a path selection step of obtaining at least two or more paths showing a high likelihood out of the at least three or more paths for getting to each state and selecting the maximum likelihood path from the obtained at least two or more paths.

26. The decoding method according to claim 25, wherein said path selection step includes a comparison step for comparing the likelihoods of all the combinations of two paths selected from all the three or more than three paths getting to each state.

27. The decoding method according to claim 25, further comprising:

an absolute value selection step for selecting the absolute value of the difference between the data corresponding to the maximum likelihood path and

the data corresponding the second maximum likelihood path.

28. The decoding method according to claim 27, wherein said absolute value selection step includes an absolute value computing step for computing the absolute value of the difference of each of all the combinations of two paths selected from all the three or more than three paths getting to each state;

the computed absolute values being compared for magnitude on the basis of the information on the outcome of comparison obtained by comparing the likelihood of each of all the combinations of two paths selected from all the three or more than three paths getting to each state in said path selection step.

29. The decoding method according to claim 27, further comprising:

a linear approximation step for computing by linear approximation a correction term added to obtain said log likelihood and expressed by a one-dimensional function relative to a variable;

said linear approximation step using as said variable the absolute value of the difference between the data corresponding to said maximum likelihood path and fed in said absolute value selection step and the data corresponding to said second maximum likelihood path.

30. The decoding method according to claim 29, wherein said linear approximation step is adapted to compute said correction term by expressing the coefficient representing the gradient of said function for multiplying said variable at least by means of a power exponent of 2.

-91-

31. The decoding method according to claim 30, wherein said linear approximation step is adapted to discard lower bits of an input data according to the power exponent expressing the coefficient representing the gradient of said function.

32. The decoding method according to claim 30, wherein said linear approximation step is adapted to discard the bits from the lowest bit to the k-th lowest bit of the input data when the coefficient representing the gradient of said function is expressed by -2^{-k}.

33. The decoding method according to claim 30, wherein said linear approximation step is adapted to compute said correction term by expressing the coefficient representing the intercept of said function by means of a power exponent of 2.

34. The decoding method according to claim 33, wherein said linear approximation step is adapted to compute said correction term by expressing the coefficient representing the intercept of said function by means of $2^m - 1$.

35. The decoding method according to claim 34, wherein said linear approximation step is adapted to discard the bits from the lowest bit to the k-th lowest bit of the n-bit input data and to invert the m bits from the k+1-th lowest bit to the m+k-th lowest bit when the coefficient representing the gradient of said function is expressed by means of -2^{-k}.

36. The decoding method according to claim 30, wherein said correction

-92-

term shows a positive value.

37. The decoding method according to claim 36, wherein said linear approximation step is adapted to make the correction term equal to 0 when a negative value is produced by computing said correction term.

38. The decoding method according to claim 25, wherein said log likelihood is a log expression of said probability with the natural logarithm.

39. The decoding method according to claim 25, further comprising:

a first probability computing step for computing for each received value a first log likelihood logarithmically expressing a first probability determined by a code output pattern and said received value;

a second probability computing step for computing for each received value a second log likelihood logarithmically expressing a second probability of getting to each state from the coding starting state in the time series; and

a third probability computing step for computing for each received value a third log likelihood logarithmically expressing a third probability of getting to each state from the coding terminating state in the inverted time series;

said second probability computing step and said third probability computing step including path selection steps respectively.

40. The decoding method according to claim 39, further comprising:

a soft-output determining step for determining a log soft-output logarithmically expressing the soft-output in each time slot, using said first log

-93-

likelihood, said second log likelihood and said third log likelihood.

41. The decoding method according to claim 40, wherein said log soft-output is a logarithmic expression of said soft-output with the natural logarithm.

42. The decoding method according to claim 39, wherein said second probability computing step and said third probability computing step include absolute value selection steps for determining the absolute value of the difference between the data corresponding to the maximum likelihood path and the data corresponding to the second maximum likelihood path showing the second highest likelihood, respectively.

43. The decoding method according to claim 39, wherein said second probability computing step and said third probability computing step include linear approximation steps for computing by linear approximation the correction term added to obtain said log likelihood and expressed by a one-dimensional function relative to a variable, respectively.

44. The decoding method according to claim 25, wherein said log likelihood is determined by computations replacing the multiplications for computing the probability by logarithmic additions and the additions for computing the probability by logarithmic maximum value computations.

45. The decoding method according to claim 44, wherein a maximum a posteriori probability decoding operation is conducted on the basis of the Max-

Log-BCJR algorithm.

46.   The decoding method according to claim 29, wherein said log likelihood is determined by computations replacing the multiplications for computing the probability by logarithmic additions and the additions for computing the probability by logarithmic maximum value computations and computations of said function.

47.   The decoding method according to claim 46, wherein a maximum a posteriori probability decoding operation is conducted on the basis of the Log-BCJR algorithm.

48.   The decoding method according to claim 25, wherein convolutional codes are decoded.